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ABSTRACT

Three experiments investigated whether word order and case markers play a role in the native speaker's comprehension of Japanese. In Japanese, verbs are at the clause-final position and the order of words other than the verb appear to be flexible. The fact that verb information does not become available until the end of a clause suggests that other types of information may be used in processing the language. In the first experiment, 52 Japanese college students were presented with scrambled sentences and regular sentences and asked whether specific words had appeared in them, to investigate processing load. No increased difficulty in processing scrambled sentences was found. In experiment 2, 52 university students were given a lexical decision task. Results indicate that responses were not dependent on word order within the task sentence. The third experiment assessed whether case-marked arguments influenced sentence processing, and found the respondents sensitive to case marking. The results of the three experiments are more congruent with non-configurational structure than with configurational structure at the stage of pre-verbal processing in Japanese. Contains 32 references. (MSE)

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Language Learning Laboratory
College of Liberal Arts and Sciences

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Technical Report No. LLL-T-26-96
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Hiroko Yamashita

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LANGUAGE LEARNING LABORATORY
College of Liberal Arts and Sciences
University of Illinois at Urbana-Champaign

Technical Report No. LLL-T-26-96

The Effects of Word-order and Case Marking Information on the Processing of Japanese

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Abstract

Many studies in processing English report that verb information plays a significant role in in processing the rest of the sentence (e.g., Boland & Tanenhaus, 1991). Japanese is an SOV, head-final language with the phenomena of scrambling and phonologically null pronouns. Due to these characteristics, the verbs are at the clause-final position, and the order of the words other than the verb appear to be flexible on the surface. The fact that verb information does not become available until the end of a clause leads one to ask whether other types of information may be utilized in the on-line processing of Japanese. The current study investigates whether word-order and Case markers play a role in the native speaker's comprehension of Japanese. Overall, no effect of word-order was observed, even though the frequency of the scrambled sentences is low. Experiment 1 found no extra processing load in processing scrambled sentences. In Experiment 2, no effect of word-order was found in the parser's decision making in computing a syntactic structure prior to the verb. On the other hand, Experiment 3 found that the parser is sensitive to the variety of Case marked arguments. The results of the three experiments are more congruent with the non-configurational structure than with the configurational structure at the stage of pre-verbal syntactic processing in Japanese.

The Effects of Word-order and Case Marking Information on the Processing of Japanese

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Many studies in processing English report that verb information plays a significant role in determining the rest of the syntactic structure, or at least the preference among the possible structures (e.g., Ford, et al., 1982; Trueswell, et al., 1994; also see Boland & Tanenhaus, 1991). In contrast, Japanese is an SOV, head-final language with the phenomena of scrambling and phonologically null pronouns. Due to these characteristics, possible structures in Japanese prior to the end of the sentence are numerous. For instance, the three arguments shown in (1) can be completed in any of the following ways. The three Case marked arguments, NP-*ga*, NP-*ni*, and NP-*o* in (1), are in what is widely assumed to be canonical order in Japanese. These arguments can all be the co-arguments subcategorized by a same ditransitive verb in a simplex sentence, as in (2).

(1) *Mary-ga John-ni ringo-o...*
Mary-nom John-to apple-acc

(2) <simplex clause completion>
[Mary-ga John-ni ringo-o (ageta)].
gave
'Mary gave an apple to John.'

In other sentences, the array of arguments may belong to different clauses; as in (3), some may be from the matrix clause and some from the relative clause.

(3) <relative clause completion>
a. [Mary-ga John-ni [[EC ringo-o (tabeta] hito]-o syookai-sita])
ate person-acc introduced
'Mary introduced the person who ate an apple to John '.
b. [Mary-ga John-ni ringo-o [[EC (tabeta] kodomotati]-ni kubaraseta]).
ate children -to let distribute
'Mary let John distribute apples to the children who ate (it=lunch, etc.).'
c. [Mary-ga [[[[[John-ni ringo-o (ageta] kodomo]-o yobitometa] onnanohito]-o mita]).
Mary-nom John-to apple-acc gave child -acc stopped woman -acc saw
'Mary saw the woman who stopped the child who gave an apple to John.'

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Alternatively, some of the three arguments may belong to the matrix clause and some to the sentential complement clause, as in (4).

(4) <subordinate clause (sentential complement) completion>

a. [Mary-ga John-ni [ringo$_i$-o (Bill-ga EC$_i$ tabeta]-to itta]).
Bill-nom ate -comp said
'Mary said to John that Bill ate an apple'.

b. [Mary-ga [EC John-ni ringo-o (ageta]-to itta]).
gave -comp said
'Mary said that (she) gave an apple to John'.

c. [Mary-ga John-ni [EC EC ringo-o (ageta]-to itta]).
gave-comp said
'Mary said to John that (she) gave an apple to (him/her)'.

Note that there are a number of possibilities for the sentence to unfold prior to the occurrence of the first verb. Furthermore, the occurrence of the first verb does not guarantee how the resulting sentence will be (e.g., Inoue, 1991; Mazuka, 1991; Mazuka & Lust, 1990). If the first verb belongs to an embedded clause such as a relative clause or sentential complement as in (3) and (4), the number of arguments which belong to the matrix clause changes depending on the type of matrix verb and/or the intended meaning of the sentence.

Various models have been proposed to account for the processing of Japanese (e.g., Inoue, 1991; Inoue & Fodor, 1995; Mazuka & Lust, 1990; Pritchett, 1991). One of them is the head-driven model, which hypothesizes that the syntactic structure is projected at the appearance of the syntactic head (e.g., Pritchett, 1991). According to this model, no structure is created in Japanese until the verb appears. Another type of model is a serial, full-attachment model (e.g., Inoue & Fodor, 1995). This model hypothesizes that one syntactic structure is pursued at a time, but a "flag" is placed during the first-pass parsing at the point where the possible alternatives exist. When the first-pass analysis turns out to be incorrect, the human parser goes back to the flags to pursue another one.

The head-driven model risks less initial incorrect syntactic computation, because the human parser presumably postpones the computation until the information from the verb becomes available. Note, however, such delay in computation is not necessary if the information which is available earlier than the verb is utilized. In an experimental study, Yamashita (Experiment 1, 1994;1996) observed that although many possible structures are theoretically computable, a simplex structure is hypothesized when three arguments (NP-*ga*, NP-*ni*, NP-*o*) appear in a canonical order in Japanese. Using the paradigm by Gorrell (1987;1989), it was assumed that the words that continue the syntactic structure which had been computed are recognized faster than the ones that do not (e.g., Gorrell, 1987;1989; Wright & Garrett, 1984). The ditransitive verb shown

in (5a) continues the preceding sentential fragment as a simplex clause, while the transitive verb in (5b) can grammatically continue the fragment only when one assumes a subordinate clause such as a relative clause or a sentential complement.

(5) a.Gakkoo-de kawaii seito-ga sensee-ni oisii kootya-o **dasita**.
school-at cute student-nom teacher-to good tea-acc served
'At school, a cute student served good tea to the teacher.'
b. Gakkoo-de kawaii seito-ga sensee-ni [[oisii kootya-o **nonda**] (hito]-o syookai-sita).
school-at cute student-nom teacher-to good tea-acc drank person-acc introduced
'At school, a cute student (introduced) the teacher (the person) who drank the good tea.'
c.*Gakkoo-de kawaii seito-ga sensee-ni oisii kootya-o **dakara**
school-at cute student-nom teacher-to good tea-acc therefore
*'At school, a cute student therefore good tea to the teacher'

Yamashita found that the ditransitive verbs in condition (5a) were recognized as a word faster than the transitive verbs in condition (5b) and the ungrammatical continuation in (5c). The reaction times for the transitive verbs in (5b) and the conjunctions in (5c) were not significantly different. The results strongly indicate the computation of a simplex structure in the ambiguous sentence fragment, NP-*ga* --NP-*ni* -- NP-*o*.

The results found in Yamashita are interesting because the simplex structure is not necessarily the most frequent structure, at least in the written text (Yamashita, 1994). The results indicate that the human parser relies on information other than the frequency of a particular word-order when processing Japanese before the verb appears. If the parser does not rely on frequency, then, what type of information is utilized in the parser's hypothesis of a syntactic structure? The most promising candidates are the Case markers attached to arguments and the order in which those Case marked arguments appear. Note that the word-order of the sentence fragment in Yamashita (1994;1996) is canonical. It is not yet known whether the simplex clause is hypothesized in (5a) because the arguments were presented in canonical order, or because there were three differently Case marked arguments. The purpose of the current study is to investigate whether the information from word-order and the variety of Case markings is utilized in Japanese.[2] More specifically, it investigates (1) whether processing sentences with non-canonical ("scrambled") word-order is more difficult than canonically ordered sentences, (2) whether a word-order affects the decision of syntactic processing before the verb appears, and (3) whether the human parser is sensitive to the variety of arguments which appear in a sequence.

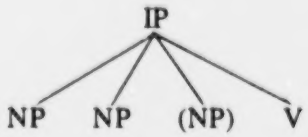
Structural representation of the scrambled sentences and the issue of configurationality

[2] The scope of the study is limited to short-distance scrambling, in which the argument in a clause is relocated to the front of a clause.

The actual frequency of scrambled sentences in Japanese is low. Kuno (1973a) notes that canonically ordered sentences (NP-*ga* -- NP-*o*) are 17 times more likely to occur than scrambled sentences (NP-*o* -- NP-*ga*). The low frequency of scrambled sentences was also confirmed by a study conducted at University of Illinois (Yamashita & Suzuki, 1995). The study found that the frequency of any type of scrambled sentences in a transcription of informal discussions was less than 1% (N=1324).

In syntactic theory, there are two ways to account for the phenomenon of scrambling in Japanese. One way is to assume that scrambled word-order is a phenomenon associated with the type of language with "flat (non-configurational) structure," as shown below (Hale, 1980; Farmer, 1980).

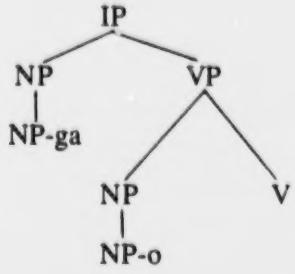
(6)*



In (6), all arguments are sisters to the verb. Notice that it is not possible to structurally distinguish the subject NP from the object NPs. In the non-configurational structure, any NP can be a subject, an indirect object, or a direct object. The advantage of the non-configurational structure is that free-word order such as scrambling is accounted for; under this approach, any word-order is base-generated, and no particular order is considered as a canonical order.[3]

In the Government and Binding framework (e.g. Chomsky, 1981), on the other hand, researchers convincingly argued for the "configurational" structure for Japanese, as shown in (7) (e.g., Hoji, 1987; Miyagawa, 1989; cf., Whitman, 1987).

(7)

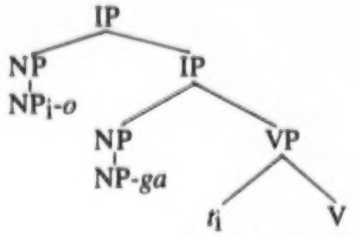


In the configurational structure, the subject NP is defined as the NP which is positioned structurally higher than the other NP or the verb. In an account of scrambling based on the configurational structure, the scrambled word-order is derived by a syntactic operation from the canonical order. The type of scrambling discussed in the current study is derived from the canonical ordered sentence NP-*ga* -- NP-*ni* -- NP-*o* by an syntactic operation of "IP adjunction"

[3] Note that an explanation for the frequent occurrence of NP-*ga* -- NP-*ni* -- NP-*o* order must still be accounted for, even if one employs the non-configurational structure for Japanese.

(Saito, 1985). The structure in (8) demonstrates how the scrambling of an Accusative Case marked argument is represented.

(8)



Compare (7) with (8). If the scrambling is indeed derived by a syntactic operation which yields the structure in (8), the structure of the type of scrambling discussed in the current study is more complex than the canonical sentence. The structure has more nodes than its canonical counterpart due to an IP adjunction. There is a chain formed between the scrambled argument and its trace. Although there is not yet a total agreement on the structure of Japanese among researchers, presently many seem to assume the configurational structure.

Experiments

In order to investigate the effects of word-order and variety of Case marked arguments in the processing of Japanese, three experiments comparing canonical and scrambled sentences were conducted. Experiment 1 examined whether any extra processing load was involved in the scrambled sentences. Experiment 2 examined whether a simplex structure was computed or such a decision was delayed if the Case marked arguments were in a non-canonical order. Experiment 3 investigated whether the parser was sensitive to the variety of these Case marked arguments.

Experiment 1: Processing load in scrambled simplex clauses

A self-paced, moving-window reading task was employed in Experiment 1 in order to find the processing load of scrambled sentences. Such task was employed because it can measure the increased reading time locally or globally. It was assumed that longer reading times in scrambled sentences, compared to canonically ordered sentences, reflect the extra processing load. Recall that scrambled sentences occur less frequently than canonical sentences, and their syntactic structures are more complex than the canonical sentence if one employs the configurational structure due to extra nodes and chains. As suggested in Pritchett and Whitman (1995), such complex structure may be less preferred. Thus processing scrambled sentences may be more costly than processing canonical sentences.

In Experiment 1, the conditions shown in (9) were compared.

(9) a. condition A: (canonical: NP-*ga* -- NP-*ni* -- NP-*o* order)

P1 P2 P3 P4 P5 P6 V

Wakai zimuin-*ga* mukuti-na syatyoo-*ni* omosiroi hon-*o* ageta.

young secretary-nom quiet president-dat fun book-acc gave

b. condition B: (NP-*ni* (Dative NP) scrambled: NP-*ni* -- NP-*ga* -- NP-*o* order)

P1 P2 P3 P4 P5 P6 V

Mukuti-na Syatyoo-*ni* wakai zimuin-*ga* omosiroi hon-*o* ageta.

c. condition C: (NP-*o* (Accusative NP) scrambled: NP-*o* -- NP-*ga* -- NP-*ni* order)

P1 P2 P3 P4 P5 P6 V

Omosiroi hon-*o* wakai zimuin-*ga* mukuti-na syatyoo-*ni* ageta.

d.condition D:(NP-*ni* (Dative NP), NP-*o* (Accusative NP)scrambled:NP-*o* -- NP-*ni* -- NP-*ga* order)

P1 P2 P3 P4 P5 P6 V

Omosiroi hon-*o* mukuti-na syatyoo-*ni* wakai zimuin-*ga* ageta.

"A young secretary gave the quiet company president a fun book."

Method

Materials. Four lists of experimental materials were created. Each list contained 24 test sentences (6 canonical ordered sentences, 6 sentences in which the Dative marked argument is scrambled, 6 sentences in which the Accusative marked argument is scrambled, 6 multiple scrambled sentences) and 84 filler sentences. Most fillers were divided by constituents larger than the words; this was to prevent subjects from pressing buttons without reading every word (p.c. Don Mitchell). However, all the target sentences and a small number of filler sentences were presented word-by-word, so that the reading times of each word are measured. At the end of each sentence, a probe word was presented, and subjects were asked to decide as quickly as possible whether or not the word had appeared in the sentence they had just read. The probe was the bare noun in the Dative Case marked NP (*syatyoo* in the example sentence in (9)). About 25 % of the target sentences and fillers were followed by a yes/no question about the content of the sentence they just read. Both the probe task and the yes/no questions served to monitor whether the subject was paying attention to the reading, as well as to distract them from noticing the test sentences.

Subjects. Fifty-two college students from Kagawa University participated in the experiment. All had normal or corrected normal vision and were not told the purpose of the study. The subjects were randomly assigned to each of the four lists.

Procedure. The sentences were presented to the subjects using a segment-by-segment, self-paced, moving-window reading presentation. The presentation was controlled by HyperCard on a Macintosh Performa.[4] Each word appeared in the position it would be in if the whole sentence were to be presented on the screen. When the subject first pressed the return key on the keyboard,

[4] The original version of the self-paced, moving window program was adapted from Nakayama (1990;1995).

the first word appeared. Then at the next button press, the first word disappeared and the next word appeared. All sentences were complete sentences. After the last word of the sentence, a period in Japanese appeared, signaling that the next word would be a probe word. When answering a probe word question, the subjects pressed the return key for "yes" and the tab key for "no."

Subjects were instructed to read the segments as quickly as possible, without sacrificing their comprehension of each sentence. Before the test session, there was a practice session with 11 sentences. Examples of all test sentence types were used during the practice session.

Results

All subjects recognized more than 85% of the probe words, indicating that they were reading carefully. The results of Experiment 1 are summarized in Figure 1.

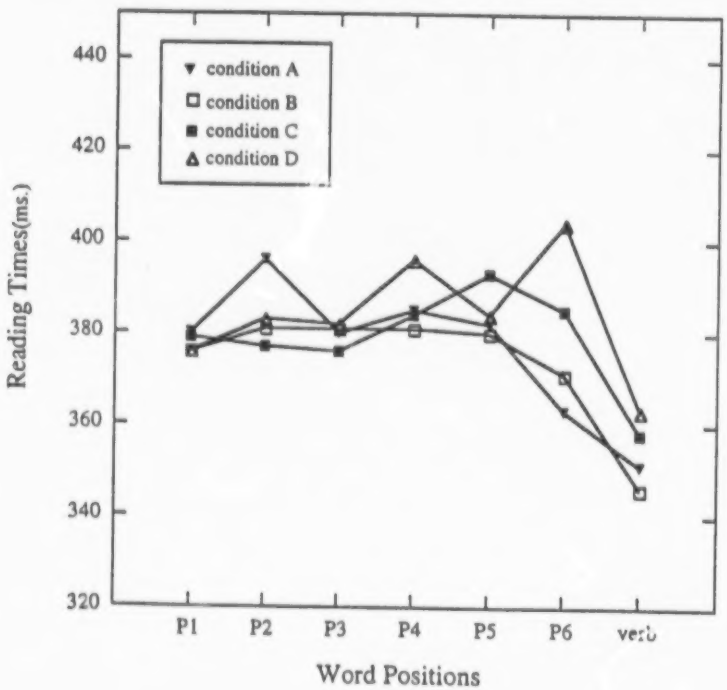


Figure 1 Mean Reading Times (ms.) per Word by Positions for Experiment 1

Analysis of variance (ANOVA) revealed no significant difference across the conditions at any position. The scrambled conditions B, C, and D, were read as quickly as the canonical order, condition A. No significant difference was observed across the conditions when the overall reading times were averaged.

Contrary to the initial speculation, there was no increased difficulty in processing scrambled sentences. The fact that the scrambled sentences were read as readily as the canonically ordered sentences leads one to ask whether the scrambled order is regarded any differently from the canonical order by the parser. Let us now examine how the parser treats both scrambled and canonically ordered arguments when making a decision on a syntactic structure prior to the verb.

Experiment 2: "Order" vs. "Variety" hypotheses

In Experiment 2, the sentences shown in (10) and (11) were compared. The sentences in (10) are from Yamashita (1994;1996). In these studies, the response times of the lexical judgment target shown in (10a) were compared with the times to judge the target shown in (10b). The targets in condition (10a) were all ditransitive verbs which completed the preceding sentence fragment *Kawaii onnanoko-ga wakai sensee-ni oisii otya-o* "a cute girl, to the teacher, good tea" in the preferred structure (the simplex sentence). On the other hand, the targets in (10b) continued the preceding sentence fragment grammatically only in the non-preferred structures (the structures with a relative or subordinate clause). In the current study, the conditions in (11), in which the preceding sentence fragment was scrambled, were added to the paradigm.

(10) Canonical sentence fragments

Kawaii onnanoko-*ga* wakai sensee-*ni* oisii otya-*o*....
cute girl-Nom young teacher-Dat good tea-Acc

target A : (ditransitive) dasita
served

target B : (transitive) nonda
drank

(11) Non-canonical, scrambled sentence fragments

Wakai sensee-*ni* kawaii onnanoko-*ga* oisii otya-*o*....
young teacher-Dat cute girl-Nom good tea-Acc

target A : (ditransitive) dasita
served

target B : (transitive) nonda
drank

"(10,11A) The cute girl served the young teacher good tea."
"(10,11B) The cute girl (told) the young teacher (that she) drank good tea"

The task used in Experiment 2 was a revision of the lexical decision task employed by Gorrell (1987;1989). It is assumed that a given target is recognized as a real word faster when it fits in the syntactic structure computed up to that point (e.g., Goodman, et al., 1981; Gorrell,

1987;1989; Wright & Garrett, 1984). Thus, the lexical decision task appears to be suitable for determining which syntactic structure(s) is/are computed at an ambiguous point.[5]

There are two possible predictions to make in terms of the effect of word-order on the computation of syntactic structure prior to the time when the target words are presented. Recall that in Yamashita (1994;1996), the recognition times of ditransitive verbs in (10A) were significantly faster than those in (10B), suggesting that the parser had computed a simplex structure. The current experiment investigates whether the same would be true even though the arguments in the preceding sentence fragments were presented in a non-canonical order. If the parser is sensitive to the order in which arguments appear and relies upon the word-order information, then the parser may commit to a structure only when the words are presented in a canonical order. It is hypothesized that when the words are scrambled, the parser does not commit to a single structure.[6] Let us call this the "order hypothesis." In this case, no difference between the recognition times of ditransitive verbs and those of transitive verbs should be observed in the scrambled conditions.

On the other hand, it is possible that the parser used the Case marking information regardless of the order in which the arguments appear. Let us call this the "variety hypothesis." According to this hypothesis, the critical information that the parser utilizes is not the order in which Case marked arguments appear, but those Case marked arguments that are present. Thus, the parser treats both canonical sentences and scrambled sentences equally. In both conditions in (10) and (11), the sentence fragments contain the same Case marked arguments (NP-*ga*, NP-*ni*, NP-*o*), all of which can be the co-arguments subcategorized by the ditransitive verb. Then, a simplex structure would be built by the third argument regardless of the word order in the preceding sentence fragment, and we would only see the main effect of verb types (transitive or ditransitive) in both conditions.

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[5] The lexical decision task in the experiments in Gorrell (1987, 1989) and in the current study is assumed to measure the effect of "post-lexical access" processing (e.g., Seidenburg et al., 1984), which should be distinguished from the "pre-lexical access" processing effect. Pre-lexical processing is an activation of certain word(s) prior to recognition, and it takes place in the lexical module. In contrast, post-lexical processing is how recognized words are integrated into the syntactic context.

[6] Inoue (1991) refers to a possible delay in making decisions in case of so-called "VP-internal scrambling," as shown below.

(i) Bob-ga ringo-o [Mary-ni atta hito]-kara moratta
Bob-nom apple-acc Mary-dat met person-from received
"Bob received an apple from the person who met Mary."

Inoue attributes the claim to an unnoticeable garden-path effect at the first verb *atta*, in comparison to the canonical word-ordered sentences. However, it is not clear whether the VP-internal scrambling is treated in the same way as the short-distance scrambling tested in the current study. Furthermore, a recent theoretical study gives evidence that NP-*ga*-- NP-*o* --NP-*ni* is base-generated, just as NP-*ga*--NP-*ni*--NP-*o* (Miyagawa, in press). If the arguments in (i) are indeed in a canonical order, then, the fact that there is no conscious garden-path effect observed in (i) must be accounted for independently of word-order.

Method

Materials. Four forms for each of the 24 test sentences were constructed, as illustrated above. These sentences were included in a list of 107 sentences. Among the sentences, 58 sentences had real word targets and 49 had non-word targets. Of the 58 sentences that had real word targets, 24 were the test sentences and 34 were fillers. Among the 49 sentences that had non-word targets, one-third had pseudo-word targets which had legal morphological markings, one-third had phonetically possible combinations of Hiragana and Kanji, and one-third had unusual combinations of Hiragana and Kanji. There were no non-words created by using Katakana.[7] About two-thirds of the non-words started off with Kanji and ended with Hiragana. One-third were wholly non-words which had Kanji and Hiragana mixed randomly. The number of characters in the target words was unified across all conditions.

For the experiment, 24 sets of test sentences such as those shown in (10) and (11) were created. Four lists were made, and each list contained only one of the conditions per sentence fragment. The lexical decision times of all the target words were independently tested in isolation prior to Experiment 2. It was confirmed that the target words in conditions A and B were not significantly different.

Thirty sentences (one-quarter of the target sentences randomly selected and one-quarter of the fillers randomly selected) were followed by a yes/no question which asked subjects about the content of the previous sentence. This secondary task was to keep the subjects' attention focused on the meaning of the sentences, as well as to monitor whether the subjects were paying attention to the content of the sentences.

Subjects. Fifty-two native speakers of Japanese from Nara University, Nara, Japan, were paid to participate in the experiment. All had normal or corrected normal vision, and were unaware of the purpose of the study. The subjects were randomly assigned to one of the four lists.

Procedure. The test materials were presented on a Macintosh Performa screen. Subjects pressed the return key of the keyboard to start each sentence. The sentences were all presented automatically, word-by-word. As soon as the subject pressed the button, an asterisk appeared at the left-center of the screen with a beep sound, signaling the starting point of the presentation. After 400 ms., the asterisk disappeared and the first word appeared for 350 ms. Each word appeared and stayed on the screen for the duration of 350 ms., in a moving-window fashion. As soon as the last word of the sentence or sentence fragment disappeared, the lexical decision target word was presented at the lower right corner of the screen, independent of where the fragment appeared.

If the target word was a real word, subjects pressed the return key. If the target was not a real word, subjects pressed the tab key. For answering the yes/no questions, which followed

[7] Katakana was not used in the non-words, despite the fact that it is possible to mix Katakana along with Hiragana and/or Kanji to create non-words. This is because Katakana characters usually spell out one entire word (such as a foreign name or an onomatopoetic expression) and mixing Katakana with Hiragana or Kanji may assist subjects in developing a strategy to rule out the non-word simply by orthography.

about one-fourth of the sentences, subjects used the y/n keys on the keyboard.[8] Each test session was preceded by a practice session in which subjects saw 17 sentences; the practice sessions included all of the sentence types from the test conditions.

Results

The data from those subjects who missed more than 20% of the yes/no questions was not used, since it was not certain if those subjects were paying attention to the meaning of the sentential context before the lexical decision target. In total, the data from twelve subjects from each list, a total of 48 subjects, was used in the analysis. The results of Experiment 2 are summarized in Table 1.

<Table I: Mean Response Times (ms.) by Word-order and Verb type for Experiment 2>

word-order	Ditransitive verbs (accuracy (%))		Transitive verbs (accuracy (%))	
canonical	594	(99.4)	657	(97.4)
non-canonical	576	(98.4)	637	(99.0)

The analysis by ANOVA revealed that there was a main effect of verb type ($F1(1, 47)=8.97$, $p<.01$, $F2(1,23)=11.07$, $p<.01$). There was no main effect caused by word-order ($F1(1,47)=.83$, $p<.36$, $F2(1,23)=1.37$, $p<.24$). The interaction between word-order and verb type was not significant ($F1(1,47)=.001$, $p<.97$, $F2(1,23)=0.27$, $p<.86$). There was no significant difference in the accuracy of lexical decision answers ($F1(3,141)=.1.14$, $p<.33$, $F2(3,69)=1.04$, $p<.37$).

Discussion

In Experiment 2, the reaction times in canonical order conditions in Yamashita (1994;1996) were replicated; the ditransitive verbs presented after the canonically ordered sentence fragments were recognized as words faster than the transitive verbs. Critically, note that the non-canonical conditions patterned exactly the same as the canonical order conditions. This is congruent with the "variety hypothesis," in which the parser utilized the Case marking information regardless of the order of the Case marked arguments.

Based on the low frequency of scrambled sentences and the syntactically more complex structure, we originally speculated that the parser relies on word-order in making decisions. Contrary to this, the results from Experiment 2 suggest that the parser is indifferent to the word-order. The results from Experiment 1, although they were null results, are congruent with those

[8] In order not to force subjects' simplex structure reading, the majority of the yes/no questions of the test sentences asked either the adjectives modifying an argument or about the existence of a particular word.

from Experiment 2. Reading the scrambled sentences does not appear to take any longer than reading the canonically ordered sentences. Moreover, the parser appears to have utilized Case information independently of the word-order when it made a decision on the syntactic computation prior to the verb. It is important to note, of course, that no claim beyond the number and type of arguments tested here may be made.[9]

If the word-order does not play a major role in processing before the verb appears, as the results of Experiments 1 and 2 suggest, we now ask whether the variety of Case marked arguments which appear before the verb plays a role. In other words, does the parser utilize the information about the multiple occurrence of the same Case markers? Or is the parser indifferent to such information? Experiment 3 will investigate this issue.

Experiment 3: Sensitivity to the variety of Case marked arguments

In order to investigate whether the parser is sensitive to the variety of Case marked arguments, the self-paced, moving-window reading task used in Experiment 1 was employed in Experiment 3. The experiment particularly aimed to investigate how first three arguments are read, since three is the maximum number of arguments in a single clause in Japanese. By examining how the first three arguments are read, with various Case marked arguments, we can examine whether the variety of Case marked arguments influence the on-line processing.

In order to have the conditions which include three differently Case marked arguments and a condition which includes two arguments marked by the same Case marker within the first three arguments, the sentence structure with a sentential complement shown in (12) were employed.

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[9] It has been suggested that there is another possible way to complete conditions in (11). If the phonologically null pronoun is inserted at the sentence-initial position, it yields the final structure as below.

(i) EC wakai sensee-ni [kawaii onnanoko-ga oisii otya-o
young teacher-to cute girl -nom good tea-acc
target A: dasita]-to itta.
served -comp said
target B: nonda]-to itta.
drank-comp said

"(iA) (I/We/He/She/They) told the young teacher that a cute girl served (someone) a good tea."

"(iB) (I/We/He/She/They) told the young teacher that a cute girl drank good tea."

If the subjects interpret the sentence as in (i), the arguments in conditions (11A) and (11B) are not exactly in the "non-canonical" order. Rather they are in canonical order for sentential complement structure, with a phonologically null subject.

It is not known whether an empty subject is postulated when the argument marked by Cases other than the Nominative case appears sentence-initially, particularly when there is no preceding context as in the current experiment. However, if the null pronoun is indeed inserted, we predict that transitive verbs in condition (11B) would be recognized as fast as (11A). On the contrary, the results show that targets in (11B) were recognized slower than (11A), indicating that the subjects did not read the sentence as shown in (i). Needless to say, however, further study is necessary as to how a sentence-initial argument marked by a Case other than Nominative Case is interpreted, with or without preceding context.

The arguments in condition A are in canonical order for a sentence with a sentential complement. On the surface, the order is NP-*ga* -- NP-*ni* -- NP-*ga* -- NP-*o*. The Accusative Case marked argument in the subordinate clause in condition B is scrambled, yielding the word-order NP-*ga* -- NP-*ni* -- NP-*o* -- NP-*ga* on the surface. Note that the first three arguments (NP-*ga* -- NP-*ni* -- NP-*o*) are analogous to the canonical order of a simplex sentence with a ditransitive verb on the surface. The word-order in condition C is non-canonical, and is not analogous to any canonical word-order. Despite the fact that the orders in conditions B and C are not identical, the two conditions have one feature in common; the first three arguments are differently Case marked, each by *ga*, *ni*, and *o*.

(12) A (canonical order for subordinate str [PP NP-*ga* NP-*ni* [NP-*ga* NP-*o* V] V])

P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**
[Denwa-de	hansamuna	gakusee-*ga*	sensee-*ni*	[tsumetai	koibito-*ga*	nagai	tegami-*o*
phone-on	handsome	student-nom	teacher-dat	cold	girlfriend-nom	long	letter-acc
						suborV	**mainV**
						yabutta-to]	itta]
						tore-comp	said

B (scrambled subordinate object [PP NP-*ga* NP-*ni* [NP-*o* NP-*ga* V] V])

P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**
[Denwa-de	hansamuna	gakusee-*ga*	sensee-*ni*	[nagai	tegami-*o*	tsumetai	koibito-*ga*
phone-on	handsome	student-nom	teacher-dat	long	letter-acc	cold	girlfriend-nom
						suborV	**mainV**
						yabutta-to]	itta]
						tore-comp	said

C (matrix indirect object & subordinate object scrambled [PP NP-*ni* NP-*ga* [NP-*o* NP-*ga* V]V])

P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**
[Denwa-de	sensee-*ni*	hansamuna	gakusee-*ga*	[nagai	tegami-*o*	tsumetai	koibito-*ga*
phone-on	handsome	student-nom	teacher-dat	long	letter-acc	cold	girlfriend-nom
						suborV	**mainV**
						yabutta-to]	itta]
						tore-comp	said

"On the phone, a handsome student told the teacher that the cold-hearted girlfriend had torn the long letter."

If the parser utilizes that information of which Case marked arguments appear regardless of word-order at least within the first three arguments, which the results of Experiment 2 seem to

suggest, then the reading of the first three arguments in B and C should not differ. This is because on the surface, conditions B and C have all three arguments marked by Nominative, Dative, and Accusative Case. Then, as the fourth argument appears, it becomes apparent that such initial hypothesis is incorrect. Thus we would expect increased reading times around the fourth argument in conditions B and C.

In contrast to conditions B and C, condition A has two Nominative Case marked arguments in the first three arguments. There are two hypotheses as to how condition A is processed. In general, the occurrence of more than one Case marker in Japanese signals the existence of another clause.[10] For instance, no more than one Accusative Case marker occurs in a single clause, which is known as the "double-*o* constraint" (Harada, 1973; Kuroda, 1978). The multiple occurrence of the Nominative Case marker *ga* is limited to particular types of predicates such as stative verbs and potential verbs (e.g., Kuno, 1973b).[11] Therefore, if the parser utilizes the information that the third argument is another Nominative Case marked argument, processing the third argument in condition A should be different from those in conditions in B and C. The reading of the argument will most likely take longer than other conditions, due to the following possibilities. If the parser creates a new node leaving the first two arguments in the former clause, and if such operation involves extra processing cost, then reading the third argument in condition A should take extra processing effort than those in other conditions. Alternatively, the parser may delay the computation momentarily upon the appearance of the third argument, to wait for some more information. Such an operation requires the storing of the unstructured temporarily, and presumably requires extra processing load. In contrast to the first hypothesis, if the parser does not utilize the information of multiple Case marking, all three conditions should be read analogously.

Method

Materials. Three lists were created. Each list contained 18 test sentences (6 sentences per condition) and 48 filler sentences. About 25% of the target sentences and fillers were followed by a yes/no question about the content of the sentence just read.

[10] For an extensive discussion of Case marking and its implications in the processing of Japanese, see Inoue (1991).

[11] Perhaps the most versatile marker is *ni*, which sometimes functions as a postposition (e.g., Sadakane & Koizumi, 1995). See below.

(i) John-wa syuumatu-*ni* Mary-*ni* kyuu-*ni* tegami-o kaita.
John-top weekend-in Mary-dat suddenly letter-acc wrote
"John suddenly wrote a letter to Mary on a weekend."

In (i), three words are marked by *ni*: the particle functioning in these cases as a postposition, a Dative Case marker, and an adverbial morpheme, respectively. It is yet to be investigated whether the parser immediately distinguishes various functions such as the case of *ni* or is blind to the information from the preceding noun. If the parser is blind to the information from the noun and only uses the information from the marking, the multiple occurrence of *ni* may not result in increased processing load.

Subjects. Fifty-nine native speakers of Japanese studying at the University of Illinois at Urbana-Champaign participated in the experiment. All had normal or corrected normal vision and were not told the purpose of the study. They were randomly assigned to one of the three lists.

Procedure. The procedure of Experiment 3 was the same as in Experiment 1.

Results

The scores of subjects who scored below 85% accuracy in answering the probe word recognition were not used in the analysis. The results of five subjects from list 1, three from list 2, and three from list 3 were not used because the subjects scored less than 85% accuracy, or the results reflected a mechanical problem. Therefore the scores from sixteen subjects for each list were used. The results of Experiment 3 are summarized in Figure 2.

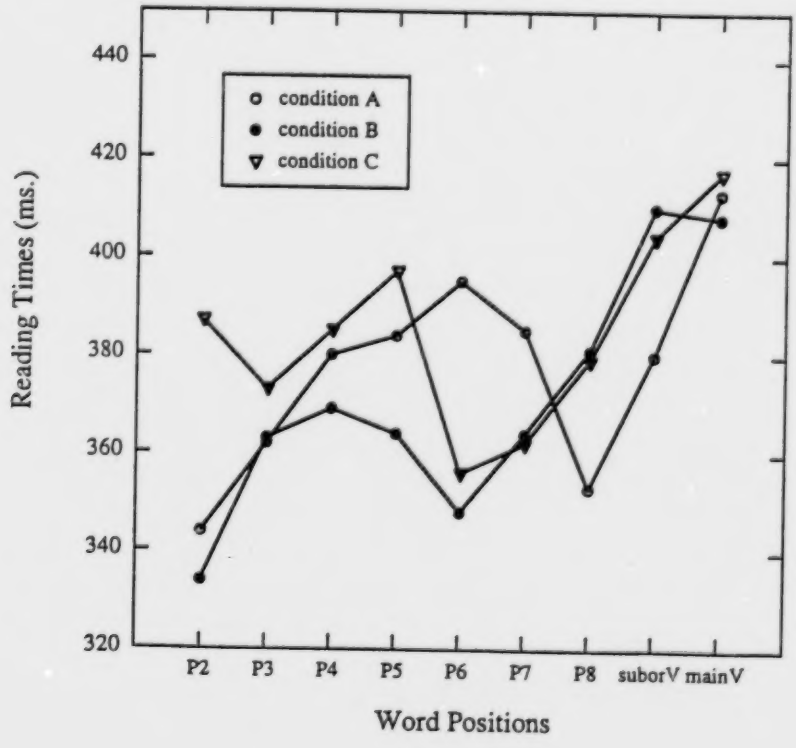

Figure 2 Mean Reading Times (ms.) per Word by Positions for Experiment 3

Reading times for the third argument (P6) were significantly different across the conditions ($F1(2, 94)= 8.35$, $p<.01$, $F2(2,34)=$, $p<.01$). The Tukey-Kramer post-hoc analysis revealed that the reading times of the word in position 6 in condition A took significantly longer than those in B and C ($p<.05$). Reading times were not significantly different at any other position. Likewise, the

probe recognition times and accuracy were not significantly different.

Discussion

The results showed significantly longer reading times in condition A at position 6, e.g., *koibito-ga* in the example (12A), than other Accusative Case marked arguments in conditions B and C. The results are of particular interest since the NP-*ga* -- NP-*ni* -- NP-*ga* order is a canonical order for sentences with a sentential complement. Despite the fact that the order in A is canonical, it took longer for the subjects to process the words at position 6 in A than those in B and C. The results demonstrate that the human parser is not blind to the types of arguments which appear before the verb. On the contrary, the parser appears to be sensitive to the fact that the third argument in condition A is of different nature from those in B and C; while the Case marking of the third argument in the latter two conditions was different from the previous two arguments, the third argument in condition A was marked by another Nominative Case.

There are two possible accounts for the longer reading times at position 6 in condition A. One possible account is that the reading times become longer because the same Case marker appeared twice within a possible clause; as mentioned earlier, the appearance of the same Case marker generally signals the presence of another clause. With this account, it is predicted that the repetition of any Case marked argument will result in the same effect. When the same Case marked argument appears twice before a verb, as in condition A, the parser may either try to build another clause without finishing the first one, or to delay the computation of the structure with an unfinished matrix clause. Either way may lead to an increased processing effort. It is necessary to test the effects of the repetition of various Case markers on processing before one concludes with this account.

The second possible reason why the reading times of the third argument in condition A were longer is due to the inherent property of the Case marker *ga*. In other words, the longer reading times at position 6 in condition A may be attributed to the fact that the Case marker *ga* appeared for the second time. In this account, the repetition of other Case markers should not be the same as the results of the current experiment. The Case marker *ga* has special syntactic and pragmatic characteristics. Syntactically, the Case marker *ga* is the first Case in the canonical order. Semantically, the *ga* marked argument tends to entail the "exhaustive-reading," which places some type of focus on the argument to which it is attached (e.g., Kuno, 1973b). With such characteristics, one may hypothesize that every appearance of *ga* triggers the creation of a new clause, leaving the previous arguments in the higher, unclosed clause (e.g., Inoue, 1991). Note that in order to attribute the results of the current experiment to the multiple *ga*-marking, one must assume that the creation of new nodes and the leaving of the unclosed clause open require extra

processing efforts. Such an assumption needs to be tested on an independent ground.[12]

Finally, how soon the response of the Case marking is reflected in reading times deserves some attention. Note that the longer reading times appeared immediately at the Case marked argument, in position 6. Since the previous words in position 5 in all conditions are adjectives, it is unlikely that the longer reading times reflected a "spill-over effect" from the previous word. The longer readings times are most likely to reflect the processing effort at the Nominative Case marked argument. This suggests that the Case information is utilized very rapidly. A similar finding on the immediate use of the Case information is also reported in an eye-tracking study in English in Traxler and Pickering (in press).

General discussion

Experiment 1 found no extra processing load in reading scrambled sentences. Experiment 2 found that there was no effect of word-order on parser's making syntactic decisions prior to the verb. In contrast, Experiment 3 found that the variety of Case marked arguments within the first three arguments affects the parser's making decisions. The results of the three experiments show that the parser is tolerant of non-canonical word-order, at least for up to three arguments. The findings lead one to ask what goes on in processing Japanese prior to the time at which verb information becomes available. Assuming a full-attachment, serial parser (e.g., Inoue & Fodor, 1995), accounting for the results assuming the configurational structure may be problematic. For example, when a parser sees the Accusative Case marked argument *ringo-o* 'an apple' at the beginning of a sentence, it must make a choice between the two types of attachment shown in (13), among others.

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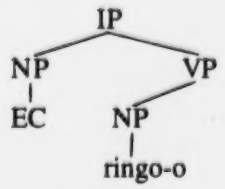
[12] In conditions B and C, the second Nominative marked argument appears at position 8, where the trend of condition A versus B and C is reversed. Although the difference at neither position was statistically supported, the trend may indicate that processing Nominative marked arguments in conditions B and C was difficult because of the appearance of the same Case marker twice. The account for the trend seems to involve more complicated issues than multiple Case markings, however. Note that the appearance of the fourth argument unambiguously signals the existence of another clause, because all four arguments do not fit in a single clause. In this sense, processing the Nominative marked argument in conditions B and C differ from that in condition A.

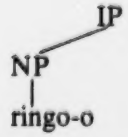
It is not clear how the four arguments are processed without the verb information. Let us tentatively assume that within the first three arguments in conditions B and C, the simplex clause is hypothesized, as the results from Experiment 2 suggests. By seeing the same Case marked argument twice at position 8 in conditions B and C, the parser may be forced to delay processing momentarily or reanalyze the initial hypothesis. However, it is not possible to complete the reanalysis of the previous structure with the information from the fourth argument alone. Due to the fact that scrambling is possible in both the matrix and the subordinate clause, a new clause boundary could be made in at least two places grammatically. Thus the increased reading times in conditions B and C could be attributed either to the temporal processing breakdown or to the delay in further syntactic computation. The increased reading times for the subordinate verb in conditions B and C may indicate the effort of reanalysis or the restarting the delayed computation in conditions B and C. The current experiments do not make explicit how more than four arguments are to be processed, and further investigation is necessary.

(13) *ringo-o....*
apple-acc

a.

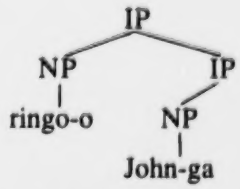


b.



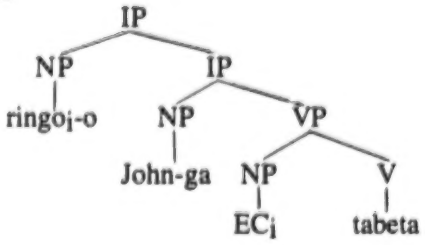
The attachment in (13a) is that of a simplex clause with a phonologically null subject pronoun. It requires the creation of an empty subject and the attachment of the object NP. Alternatively, as in (13b), the Accusative Case marked argument may be directly attached to the spec of IP. If the Minimal Structure principle (Inoue, 1991) is in operation, the less complex structure (13b) must be chosen. However, it is not clear when the trace of the Accusative Case marked argument is posited and how it affects the interpretation, if at all. For simplicity's sake, let us consider the case in which the verb is transitive, taking a Nominative Case marked argument and an Accusative Case marked argument. If the Nominative argument appears after *ringo-o*, another IP is created, as shown below.

(14) *ringo-o John-ga....*
apple-acc John-nom



As a Nominative Case marked NP appears, another IP is created. When the transitive verb appears, the structure will presumably be as follows.

(15) *Ringo-o John-ga tabeta.* "John ate an apple."
apple-acc John-nom ate



Assuming the configurational structure for Japanese, the scrambling is handled as a stack of IPs, as shown in (15). The stacked IPs are not unusual in Japanese. A similar structure has been proposed for the multiple Nominative Case marking in Japanese (e.g., Tateishi, 1991).

Another way to interpret the findings is through a non-configurational phrase structure as shown in (6). This structural representation captures the results of the current study better than the configurational structure. If one assumes the non-configurational structure, any Case marked argument is attached directly under the main clause, as a daughter of an IP. Therefore the complexity of the so-called scrambled sentences is no more than that of the canonically-ordered sentences. This is congruent with the results of Experiment 1, in which no extra processing load in scrambled conditions was detected. Note that any word-order can be considered a "base" or "original" word-order under the non-configurational structure. The results of Experiment 2, in which the parser treated both NP-*ga* -- NP-*ni* -- NP-*o* and NP-*ni* -- NP-*ga* -- NP-*o* orders equally, is not surprising if all word-orders are treated as equal by the parser.

The primary goal of the current study is not to determine the best description of the syntactic structure of Japanese. It is essential to investigate, however, which syntactic structures are computed, if at all, at various points when one processes a sentence. The results may suggest that the fundamental syntactic structure of a sentence may change as the sentence progresses. At an early stage, before the first verb appears, the parser simply tries to attach all the arguments under a single (matrix) clause, unless it sees a "warning" such as the appearance of the same Case more than once. At this stage, the non-configurational structure might describe the syntactic structure more naturally than the configurational structure. Nevertheless, various types of evidence in theoretical linguistics, such as binding, demonstrate that there is certainly a difference between the syntactic/semantic characteristics of the subject and those of the objects (e.g., Hoji, 1987; Whitman, 1987). One possible way to account for the two *prima facie* conflicting pieces of evidence is the change in the representation by the stage of processing. The configurational structure may represent the phrase structure of Japanese at an interpretation level, post on-line stage, while non-configurational structure is initially computed at the initial stage of processing, before the first verb appears.

Finally, it must be noted that the results in Experiment 1 show a null effect of word-order. Therefore there is a chance that the extra processing load may be detected either when the

experiment is duplicated or when a different task is employed. Since the experiment was a word-by-word presentation, the subjects could have developed a strategy in which they paid more attention to individual words than their sequencing (p.c. Reiko Mazuka). There is a similar possibility for the results in Experiment 2, since no effects of word-order were observed when the words were presented in a word-by-word fashion. Needless to say, further study with both identical and different presentation are necessary.

In summary, the current study reports no extra processing load of scrambled sentences. The additional experiments show that there was no effect of word-order in making syntactic decisions prior to the verb. This suggests that the parser is tolerant of variation in order of Case marked arguments. The variety of Case marked arguments, on the other hand, does seem to affect how the parser makes decisions. It shows that such information is utilized rapidly. The exact source of increased reading times when the same Case marker appears more than once within three arguments, as well as how more than four arguments are processed, must be investigated in the future.

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